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ABSTRACT

One hundred eighty 4-man groups (90 of men and 90 of women) using 3 types of net (All-Channel, Wheel and Circle) under 3 conditions (Planning Period (PP), Rest Period (RP) and Control) were run in a single session with 5 complex problems to determine whether a single 2-minute planning period after solution of the first problem would result in significant improvement in performance on subsequent problems. Results indicate that while there may be a tendency for PP groups (except for Wheel Women) to show an improvement on time and messages, this improvement failed to reach a level of statistical significance. Ratings of their own performance did indicate that PP groups had higher morale at a borderline level of significance. Other results confirm previous reports of the superiority of All-Channel and Circle nets on time and morale, wheels on use of fewer messages to solve problems. Interaction effects for sex and net were significant showing women superior on All-Channel and Circle nets, men on Wheels on time and messages. Women also had significantly higher scores on self-ratings of satisfaction and cooperation. (Author/TA)

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GROUP PLANNING AND TASK EFFICIENCY WITH COMPLEX PROBLEMS

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SUMMARY

One hundred eighty four-man groups (90 of men and 90 of women) using three types of net (All-Channel, Wheel and Circle) under three conditions (Planning Period (PP), Rest Period (RP) and Control) were run in a single session with 5 complex problems to determine whether a single 2-minute planning period after solution of the first problem would result in significant improvement in performance on subsequent problems. Results indicate that while there may be a tendency for PP groups (except for Wheel women) to show an improvement on time and messages, this improvement failed to reach a level of statistical significance. Ratings of their own performance did indicate that PP groups had higher morale at a borderline level of significance.

Other results confirm previous reports of the superiority of All-Channel and Circle nets on time and morale, Wheels on use of fewer messages to solve problems. This investigation checked performance differences between men and women, a factor not previously examined systematically. Interaction effects for sex and net were significant showing women superior on All-Channel and Circle nets, men on Wheels on time and messages. Women also had significantly higher scores on self-ratings of satisfaction and cooperation.

INTRODUCTION

A great deal is known about learning where the individual is alone and confronted by a problem. Less is known about what happens in a group learning situation. Some preliminary investigations have given indication (Shure, Rogers, Larsen and Tassone, 1962; Lawson and Lawson, 1967) that group planning aids in the solution of simple problems. Will group planning help with more complex problems? Since groups are organized in different ways: task-oriented vs. social; democratic vs. authoritarian, we have tried to set up some paradigms which may be of help in trying to understand how people work together in solving problems. The rationale is that time spent on organization at the beginning of a problem-solving session would ultimately mean greater efficiency.

The total academic picture has many situations that involve group learning. Some are formal as in many classrooms; others may be informal as in committee work, team sports, or theater production.

The results of this investigation were intended to yield information as to what type of group structure combined with planning would yield best results in a specific type of learning activity--the solution of complex problems.

Communication networks have been used by psychologists as models of various types of learning situations. Investigators have used nets of three, four, or five members with many different types of communication patterns. Among the more common types of net which have been used (see Figure 1) are the All-Channel in which every member can communicate directly with every other member, the Wheel

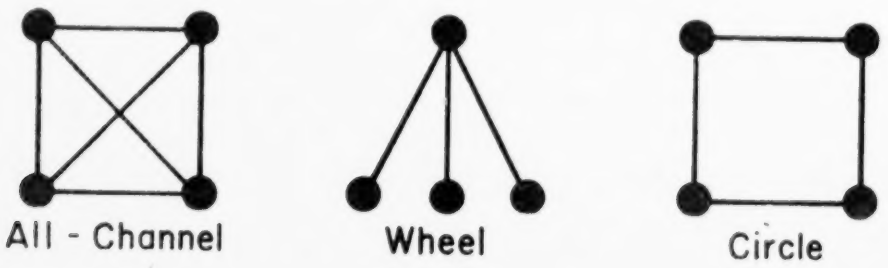

Figure 1. The Communication Nets

where only one member at the center can communicate directly with all the members, the others must route their messages through him, and the Circle, where members can communicate only with the two adjacent members. The rationale for using nets is that they are analogous to communication systems in everyday business and social life--the All-Channel, for example, is similar to an open committee.

Besides structure there are several other aspects of communication nets that can be studied. One of these is type of problem. Leavitt (1951) used simple symbol problems; Shaw (1954a, 1954b) used arithmetic problems and Shaw, Rothschild and Strickland (1957) used human relations problems. Glanzer and Glaser (1961) and Shaw (1971) have given an excellent critique of communication net research. Guetzkow and Simon (1955), Guetzkow and Dill (1957), and Shure, Rogers, Larsen, and Tassone (1962) investigated the effects of intertrial organization periods on task efficiency. These investigators used five-man groups that solved simple problems of the Leavitt type.

Using the All-Channel net, Shure had groups solve 20 problems under three conditions: (1) Separate Planning; (2) Cotemporal Planning; and (3) No Planning. Under the Separate Planning (SP) condition there was a two-minute intertrial period between each of the 20 task trials in which Ss were permitted to send any messages they wished. During the task problem session, however, they were allowed to exchange extra-task (planning) messages. The No Planning (NP) groups were given intertrial periods just as the SP groups were but were not allowed to exchange extra-task messages in either the task or the intertrial periods. NP Ss were instructed that during the intertrial periods they could write any messages they would like to send but that these messages would not be transmitted.

The results with the Shure et al. research indicated that the SP groups were superior. The rationale was that when planning takes place concurrently with activity that group members give up planning efforts because of the pressure of the immediate situation. In a follow-up of the Shure study Lawson and Lawson (1967) again using symbol problems but with four-man groups used a single planning period instead of many as Shure did. All-Channel men, All-Channel women and Circle women were used. The results indicate that the planning period significantly improved scores of All-Channel women on time and messages, the Circle women on messages, the All-Channel men on number of errors.

The results with the simple problems, using a single planning period, seemed promising enough to warrant further work with problems at a higher rate of difficulty. Arithmetic problems have been previously used in several investigations (Shaw, 1956; Lawson, 1964) and furnish a useful model for more complex problem solving.

Shaw (1971) and Lawson (1964a, 1964b) have reported that type of net and complexity of the problem affect efficiency. Thus while Wheel groups solve symbol problems the fastest, All-Channel and Circle groups solve arithmetic problems more quickly.

The factor of sex differences in group problem solving is also of some interest. Lawson (1964a) and Lawson and Lawson (1967) have previously reported some sex differences on symbol problems but systematic comparisons between men and women have not been made previously.

The specific aims of this investigation were to determine whether:

1. introduction of a planning period would improve performance on more complex problems as it did on simple problems. Specifically, that the addition of a planning period after solution of the first problem would lead to enhanced performance.

2. differential performance with planning period takes place as a function of type of net.

3. control groups given a rest period to compensate for the time spent by planning period groups on planning also improved.

4. sex differences exist between the performances of men and women.

METHOD

Apparatus

The apparatus in this experiment, modeled directly after that of Shaw (1954a) is the same as that used in previous investigations (Lawson, 1964a, 1964b, 1965) and is similar to that of Leavitt (1951), Guetzkow and Simon (1955) and Shure et al. (1962). Figure 2 shows the set-up. It consists of four cubicles connected by slots. Ss communicated by writing messages on cards and passing them through the slots. The patterns used were: All-Channel, Circle, and Wheel.

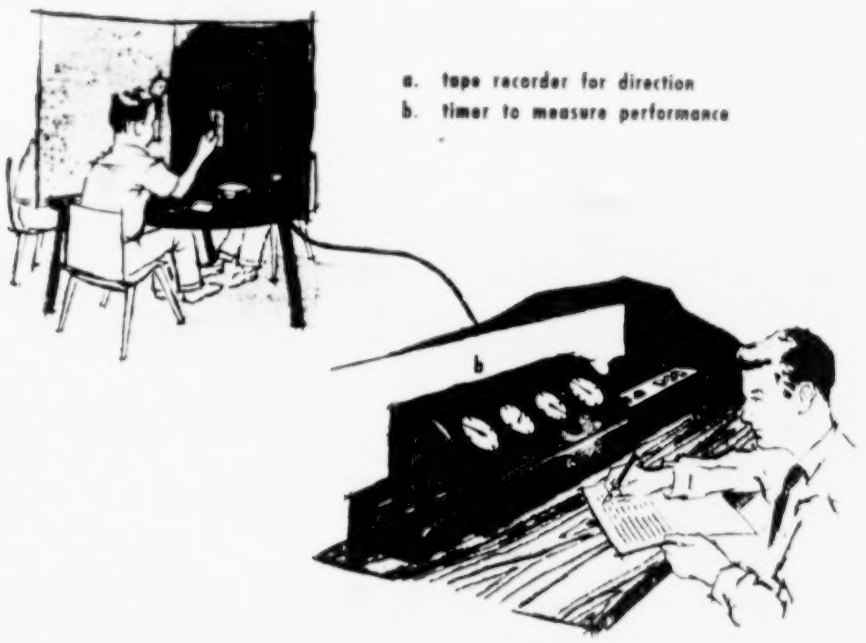

Figure 2. The Experimental Set-up

Procedure

Ss were 180 groups of college students who voluntarily participated in a single problem-solving session of about one hour. Each group had four members who solved five of the mathematics type of problem taken from those used by Shaw and Rothschild (1956). The sample problem is shown below.

> Statement of problem-- "You are a staff group for a manufacturing company. You must decide which of four types of appliance to manufacture. The type of appliance are toasters, waffle irons, mixers, and radios. Select the one which will yield the greatest net total profit. Which type of appliance do you manufacture?"
>
> Items of information needed to solve:
>
> 1. The company makes $3 net profit on each mixer.
> 2. The company makes 50 mixers a day.
> 3. The company makes $4 profit on each radio.
> 4. The company makes 50 radios a day.
> 5. The company makes $2 profit on each waffle iron.
> 6. The company can make 75 waffle irons per day.
> 7. The company makes $1 profit on each toaster.
> 8. The company can make 100 toasters per day.

There are eight items of information necessary for the solution of each problem. At the beginning of each problem each S was given an envelope containing the problem and two of the items of information. The order of presentation of problems was random but was the same for all conditions. The instructions were presented by tape recorder.

The three dimensional design had each sex separately with three types of net: (see Figure 3) All-Channel, Circle and Wheel and three types of conditions: planning period (PP), rest period (RP) and

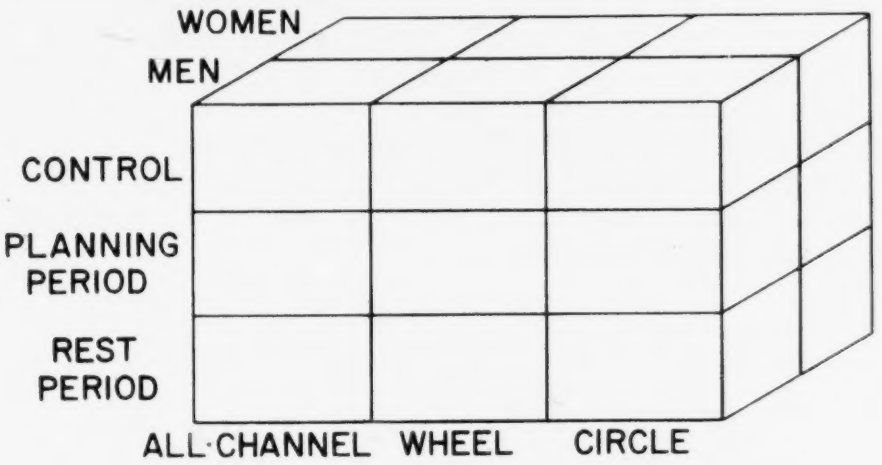

Figure 3. The Experimental Design

Control. (The original design was not intended to determine sex differences but preliminary work indicated that there might be sex differences. The rest period condition was also added as an additional control). Thus there was a total of 180 groups: 10 in each condition.

Before beginning the trial series, each S worked out the sample problem by himself without using the channels. Then all groups solved the first problem. The control groups then went on to solve the remaining four problems. After the first problem those groups in the PP condition were instructed to spend 2 minutes communicating through the channels open to them "to improve the group performance." Then they went on to the remaining problems. The RP groups were given a similar 2-minute period but could not send any messages, they could only rest. This condition was to compensate for possibly recovery from fatigue that the PP groups might have and to equate the time. The Control groups were not given the 2-minute period but could send planning messages during the regular trials.

The decision to use a single planning period rather than several was based upon analysis of the previous work of Guetzkow, Shure and Lawson and Lawson. Pretesting did seem to indicate that the single 2-minute planning session would be of benefit although there was some question as to whether there would be differential effects between men and women. Additional planning periods did not seem to be of benefit.

After all of the problems had been completed, Ss filled out ten-point rating scales dealing with (1) overall satisfaction, (2) group cooperation, and (3) group performance.

RESULTS

Scores were computed on the basis of time, messages, and morale. The means are shown in Table 1. A two by three by three analysis of variance (sex, type of net, and type of condition) was performed for time, messages and morale for testing the main effects. These results are shown in Tables 2, 3, 4, 5, and 6. Chi square analysis was used for errors.

The results with Problem 1 (before any experimental procedure) serve as a basis for equating the group in the three conditions of Planning, Rest Period, and Control. Scores on the various measures were combined for Problems 2-5.

Table 1

MEAN SCORES FOR TIME, MESSAGES, ERRORS, AND MORALE:
PLANNING PERIOD, REST AND CONTROL GROUPS

	All-Channel					
	Men			Women		
	Control	PP	RP	Control	PP	RP
Time:						
Problem 1	12.93	13.36	11.31	11.33	10.81	11.20
Problems 2-5	29.54	24.78	24.36	20.83	19.12	25.08
Messages:						
Problem 1	45.8	44.8	36.8	43.9	43.2	41.0
Problems 2-5	147.1	127.1	128.1	118.0	97.4	133.0
Errors:						
Problem 1	4	5	2	2	4	2
Problems 2-5	4	6	8	5	10	9
Morale:						
Satisfaction	7.00	6.62	6.75	7.52	7.02	7.32
Cooperation	6.62	6.67	6.35	7.75	7.35	6.85
Performance	5.55	5.70	5.40	5.85	6.05	5.90

(Table 1 continued)

	Wheel					
	Men			Women		
	Control	PP	RP	Control	PP	RP
Time						
Problem 1	11.19	11.05	14.33	15.34	12.76	14.73
Problems 2-5	26.90	22.16	26.85	29.62	33.96	28.74
Messages:						
Problem 1	24.2	24.7	33.0	30.2	31.8	40.5
Problems 2-5	63.3	62.3	97.8	76.9	108.4	92.8
Errors:						
Problem 1	4	5	6	5	3	5
Problems 2-5	4	10	14	4	7	6
Morale:						
Satisfaction	5.50	5.58	5.18	5.83	5.93	5.58
Cooperation	6.28	6.63	5.73	6.98	6.75	6.90
Performance	5.45	5.73	5.03	5.20	5.40	5.38

	Circle					
	Men			Women		
	Control	PP	RP	Control	PP	RP
Time:						
Problem 1	13.00	12.33	12.04	10.41	9.83	11.71
Problems 2-5	30.57	26.91	27.58	25.77	23.64	25.22
Messages:						
Problem 1	36.9	42.1	42.4	39.0	30.8	32.5
Problems 2-5	136.5	133.8	130.1	138.0	116.4	118.6
Errors:						
Problem 1	3	5	3	1	2	2
Problems 2-5	8	4	7	7	2	9
Morale:						
Satisfaction	7.10	7.00	6.95	7.17	6.90	7.35
Cooperation	7.00	6.73	6.98	7.47	7.00	7.35
Performance	5.58	5.66	5.90	5.97	5.40	6.07

Table 2

Analysis of Variance of Time

Source	df	MS	F	P
Sex (A)	1	32.70	--	--
Net (B)	2	258.39	3.56	.03
Condition (C)	2	67.22	--	--
Sex X Net (A X B)	2	453.81	6.26	.003
Sex X Condition (A X C)	2	87.85	--	--
Net X Condition (B X C)	4	18.82	--	--
Sex X Net X Condition (A X B X C)	4	93.20	--	--
Within Groups	162	72.51		

Table 3

Analysis of Variance of Messages

Source	df	MS	F	P
Sex (A)	1	.04	--	--
Net (B)	2	3.80	21.39	.0001
Condition (C)	2	.13	--	--
Sex X Net (A X B)	2	.52	2.98	.05
Sex X Condition (A X C)	2	.0076	--	--
Net X Condition (B X C)	4	.27	--	--
Sex X Net X Condition (A X B X C)	4	.28	--	--
Within Groups	162	.17		

Table 4

Analysis of Variance of Satisfaction

Source	df	MS	F	P
Sex (A)	1	4.92	5.19	.03
Net (B)	2	42.09	44.46	.0001
Condition (C)	2	.70	--	--
Sex X Net (A X B)	2	.60	--	--
Sex X Condition (A X C)	2	.28	--	--
Net X Condition (B X C)	4	.66	--	--
Sex X Net X Condition (A X B X C)	4	.07	--	--
Within Groups	162	.95		

Table 5

Analysis of Variance of Cooperation

Source	df	MS	F	P
Sex (A)	1	16.35	16.12	.0001
Net (B)	2	4.75	4.69	.01
Condition (C)	2	1.58	--	--
Sex X Net (A X B)	2	.62	--	--
Sex X Condition (A X C)	2	.69	--	--
Net X Condition (B X C)	4	.91	--	--
Sex X Net X Condition (A X B X C)	4	.62	--	--
Within Groups	162	1.01		

Table 6

Analysis of Variance of Performance

Source	df	MS	F	P
Sex (A)	1	.94	--	--
Net (B)	2	3.00	6.62	.002
Condition (C)	2	.06	--	--
Sex X Net (A X B)	2	.85	--	--
Sex X Condition (A X C)	2	.70	--	--
Net X Condition (B X C)	4	1.01	--	(.06)
Sex X Net X Condition (A X B X C)	4	.30	--	--
Within Groups	162	.45		

Time

Examination of Table 2 indicates no significant main effect for either sex or condition. There is a significant difference for type of net ($F = 3.56$, $p = < .03$) as would have been predicted from earlier studies. The All-Channels were the fastest, followed by Circles and Wheels. While there is no overall superiority for either sex, there is a significant sex by nets interaction ($F = 6.26$, $p < .003$). Women were superior on the All-Channel and Circle nets, men on the Wheels (Figure 4).

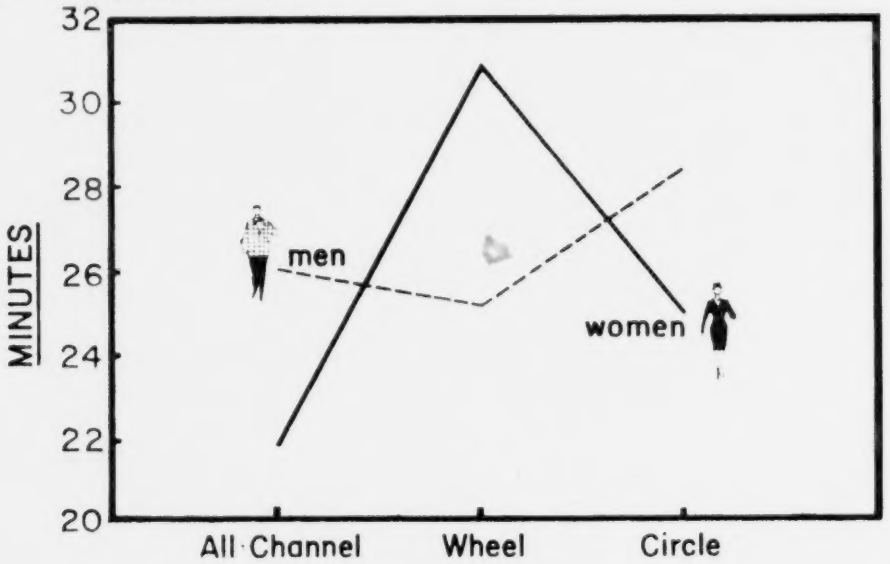

Figure 4. Comparison of Time Scores by Men and Women and Type of Net

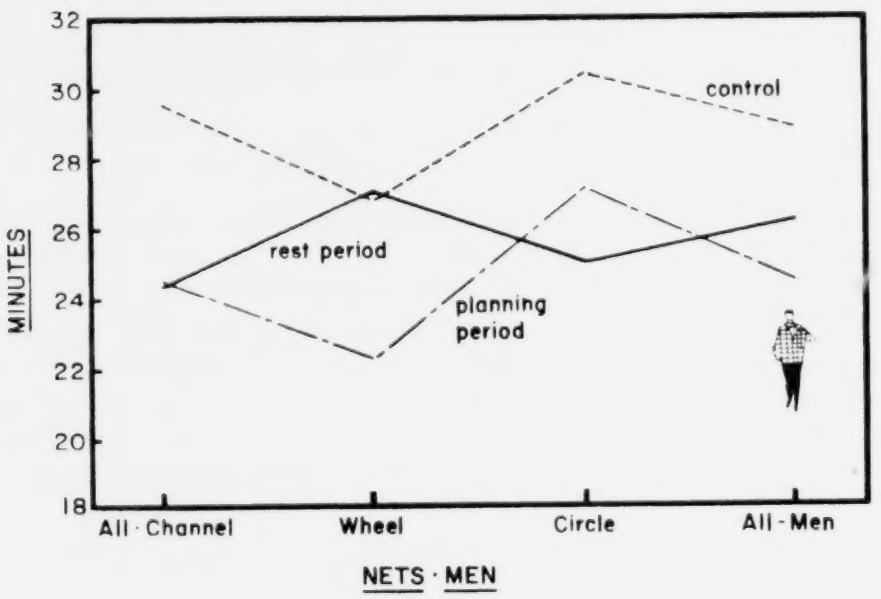

Figure 5. Effect of Planning Period and Time Scores For Men by Type of Net

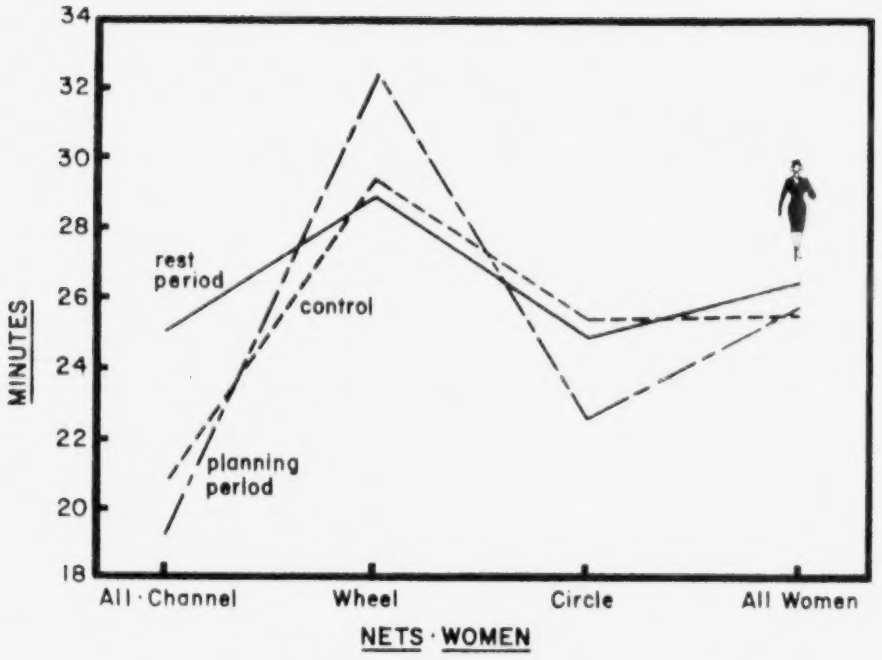

Figure 6. Effect of Planning Period and Time Scores for Women by Type of Net

The results testing the main hypothesis, the effect of planning by sex and net are shown in Figures 5 and 6. While the figures appear to confirm the hypothesis that planning improves performance, the mean time (both sexes combined) for the control condition for Problems 2-5 was 27.20 minutes; for the PP groups, 25.09 minutes; for the RP groups, 26.30 minutes the statistical analysis does not bear this out ($F = .92$, $p < .39$). Examination of the data appears to indicate a high level of variability. The Wheel women PP groups seem to be quite different from the general pattern and mitigate against the hypothesis. Other interactions were non-significant.

Messages

The results with the message analyses are shown in Tables 1 and 3. Virtually all messages sent by all groups (except for a few messages during the special planning period by the PP groups) were task messages. As the analysis of variance (Table 3) shows the significant main effect was for net and the interaction was for sex and net. The average number of messages sent for All-Channel groups was 125.2; for Wheels, 83.5; for Circles, 128.9. The Wheels sent clearly fewer messages. The mean number of messages sent by condition were: Control, 113.3; PP, 107.6; RP, 116.8. While suggestive these results failed to reach a level of statistical significance. The interaction effect is shown in Figure 7. As compared with men, women tended to send fewer messages in the All-Channel and Circle nets but more in the Wheel condition. This was significant at the .05 level.

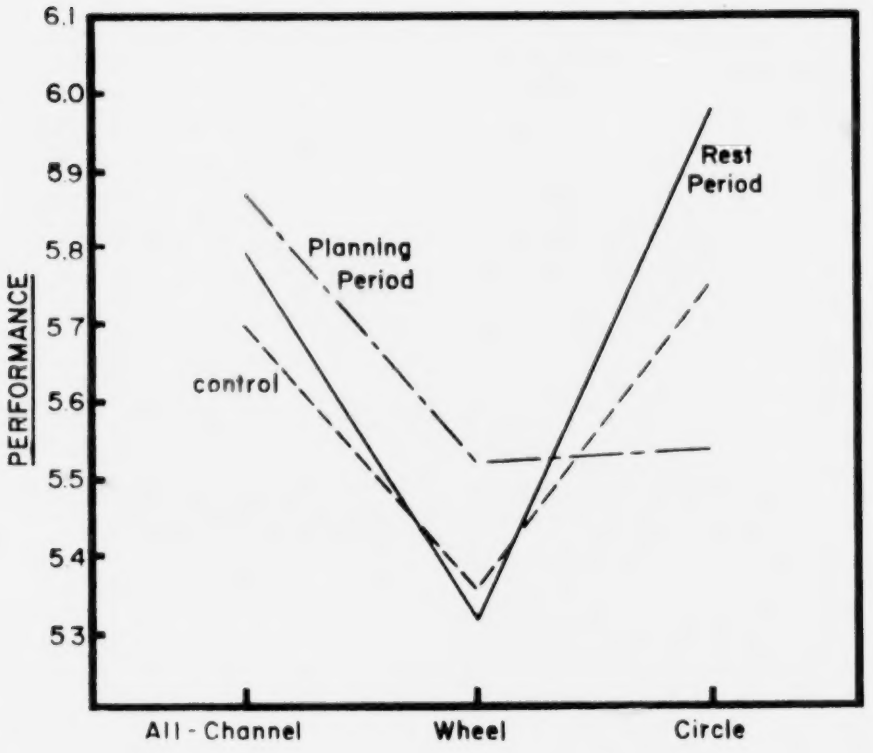

Figure 7. Interaction Effect of Sex and Type of Net and Number of Messages

Errors

An error was defined as an incorrect answer by any of the four members of the group. The total number of errors for the PP groups was 37; RP, 53; Control, 31. Thus the control groups actually did better. In a Chi square analysis the RP groups were shown to have significantly more errors $p < .05$.

Morale

Morale was measured by ratings on the three scales, satisfaction, cooperation and evaluation of group performance. Tables 1 and 4 show the results for satisfaction. Sex and net were main effect significant factors. The women had a mean of 6.74; men, 6.41 indicating higher satisfaction for women. For nets the means were: 7.03 for All-Channel, 5.60 for Wheel, 7.08 for Circle. Wheels were significantly lower.

The pattern for ratings on cooperation was similar (Tables 1 and 5). The mean for men, 6.55; women, 7.16. As Table 5 shows, women clearly perceived a higher level of cooperation between group members. For the nets, All-Channel, 6.93; Wheel, 6.54; Circle, 7.08.

The final measure of morale, performance, is shown in Tables 1 and 6. There is a significant main effect on net. The All-Channel mean is 5.73; Wheel, 5.36; Circle, 5.76, again indicating the Wheel groups as significantly lower. There is also an interaction effect approaching significance (.06 level) between net and condition. The conclusion being that rating of performance is a function not only of the type of net but also the condition. While PP All-Channel and Wheel groups had the highest performance scores of the three conditions, the Circle PP groups had the lowest.

DISCUSSION

As the results seem to have indicated, the major hypothesis of this investigation was not supported. While there may have been some suggestion that planning seems to improve performance in terms of time or messages, there was some suggestion that on the morale measure of rating on performance, All-Channel and Wheel PP groups did have significantly higher scores. This may be some indication that the planning period has some kind of facilitating effect.

In undertaking this investigation it was decided to vary type of net and sex. Now it appears that it might have been more fruitful to have varied the number and length of the planning period session or at least varied some aspect of the planning period. While the Ss seem to have made some improvement as the result of the session, it did not seem to be enough. The short planning session did appear to be enough with the symbol problems but with the more complicated arithmetic problems, the time may have been just too short. It is possibly also true that the planning session could have been improved by more specific directions or perhaps by furnishing each S with a more specific diagram of the structure of the net. Perhaps variations such as these might be undertaken by a future investigator. In any case, it is felt that more could be done with the planning session.

There were some net gains with the investigation, however. The study did confirm significant net differences on each of the measures. Time: All-Channel faster than Circle < Wheel; Messages: Wheel least, then All-Channel and Circle about the same; Errors: All-Channel and Circle < Wheel; Satisfaction: Circle highest and All-Channel high, Wheel lower; Cooperation: Circle and All-Channel high, Wheel lower; Performance: Circle and All-Channel high, Wheel lower.

Other major differences were between the sexes and showed up in the various analyses. There were two sex by net interactions, on time and on messages. The conclusion from both of these seems to be that women are better on All-Channel and Circle nets where the responsibility is more evenly divided,and poorer than men in the Wheel net. Whether we could generalize that women have greater difficulty in following instructions in an unevenly structured situation we cannot say, but this result might be worth following up. It is also true that on two of the three measures of morale, women had significantly higher scores.

In conclusion, we can say that although the investigation failed to give satisfactory support for the notion that a planning period as hypothesized would significantly improve performance. Several significant sex differences were obtained indicating (1) interaction effect between sex and net on performance, and (2) higher morale in general for women.

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